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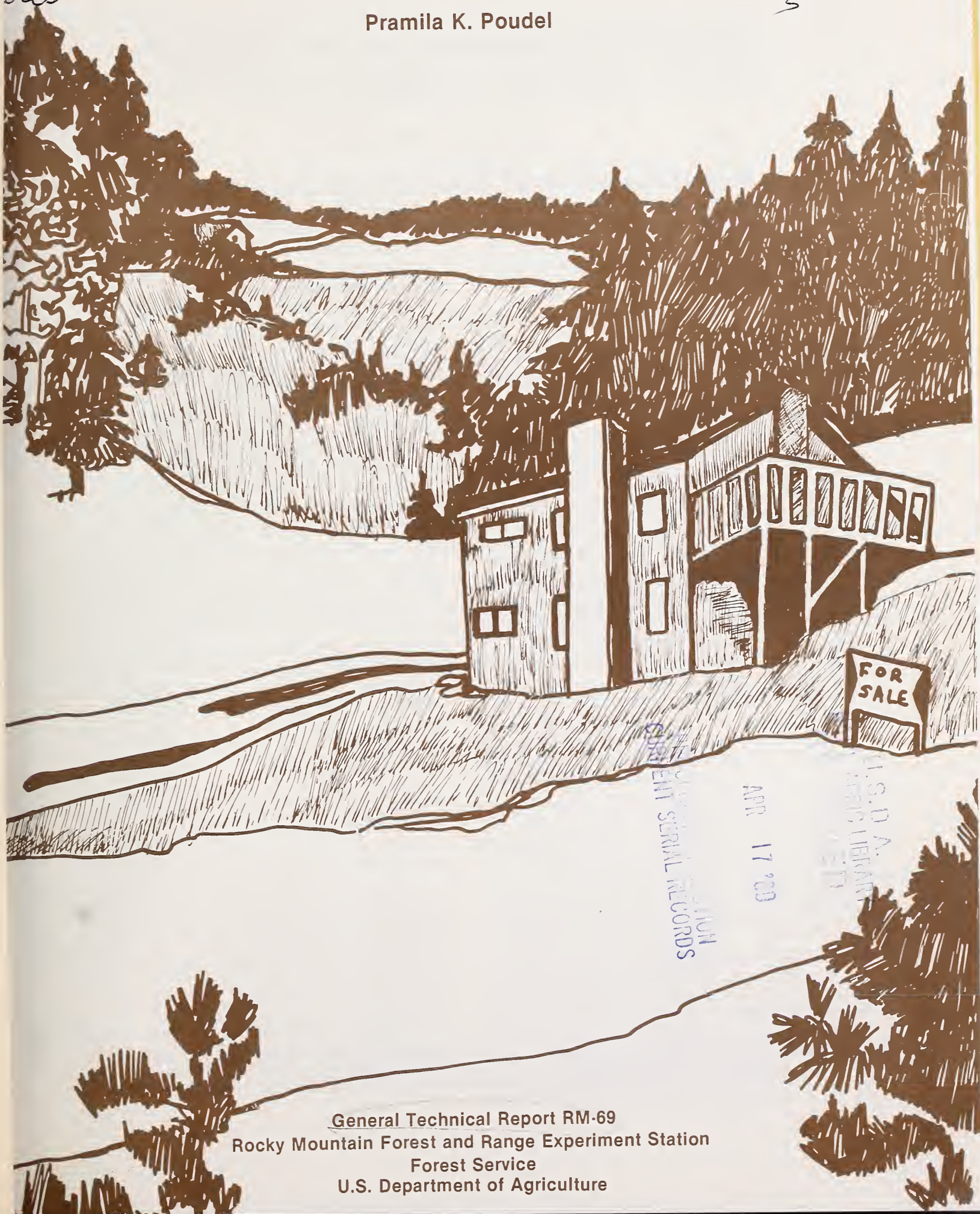

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Abstract

The social benefits derived from public environment improvement projects are one important justification for increasing such projects. Economic theory predicts environmental benefits are capitalized as increased property values. This paper reviews several empirical studies which use differential property values to demonstrate this capitalization.

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Total outlays for environmental concerns have increased by 210% since 1973 (Office of Management and Budget 1979). Since economic resources are limited, allocating them on the basis of sensible and consistent criteria of project worth has become increasingly important. Investment decisionmakers need measures which enable them to compare the benefit derived from spending equal numbers of dollars on vastly different projects.

Decisionmakers have received little guidance in selecting an appropriate appraisal method for evaluating projects. Consequently, public investment decisions about environmental programs often suffer from inadequate information about the economic benefit.

The focus of this study is only those public programs which involve improving residential attributes, (e.g., public parks, playgrounds, lakes, reservoirs, open space, air quality, and other environmental amenities). Such environmental amenities are preserved or developed because of the belief that natural environment and outdoor recreation help people build and maintain physical and psychological health (Frank 1962).

In a consumer-sovereign society, economic value is traditionally thought of in terms of utility to the users (consumers) and this utility is measured by money. So, consumers' willingness to pay for a product is thought to measure the value of a given product. In a competitive exchange economy, consumers' willingness to pay is assumed to be registered in the market price; therefore, the social value of that product is measured by the price the product would bring in the market.

Unfortunately, most of the environmental products, such as scenic beauty, open space, and clean air, are not usually traded in the market, even though they are deemed highly useful. Such goods are provided free; so there are no directly observable market prices which can be conveniently interpreted as the consumers' willingness to pay for such products. This sharply limits the possibility of actually measuring the benefits on the basis of market prices as one would be able to do in the case of tangible and marketed products, hence the need for developing indirect methods of measuring the dollar value of environmental benefits accrued from public projects.

Environmental Differential

Public programs, such as air pollution control and preserving a site as an amenity area, generally have locational impacts. Such programs provide differential geographical advantages by enhancing the utility of areas differently in terms of availability of or proximity to amenities. If consumers prefer to live near an area where such facilities are made available, they will be willing to offer a higher price for such property than for a similar property elsewhere. The price of otherwise comparable properties close to amenities would be bid up above the price of properties without such proximity to amenities. Thus a differential price will result depending on proximity to amenities.

The property price differential or "locational rent" resulting from proximity to environmental amenities may be interpreted as the value of the amenity. Consequently, the marginal value of a public environmental project can be measured in terms of the increase in land value in the vicinity of the environmental project.

The rate of property price or rent changes as proximity changes is known as rent gradient in economic literature. A considerable number of recent studies dealing with the measurement of the environmental benefits of public environmental projects have utilized the property value approach to estimate the consumers' demand price for environmental services.

Use of the property value procedure to estimate the gains from public environmental programs is based on the assumption that residential property prices reflect not just the structure and quality of building material embodied in the property, but also the surrounding subjective valuation which the buyer places on the property.

Capitalization Theory

When land is bought, what is being exchanged is an entitlement either to income from the property or to enjoyment of the land. A capital asset is being exchanged, the market price of which is based on the value of future net benefits that the asset is expected to generate. From a theoretical point of view, the value of any productive land roughly equals the sum of all its economic net benefits discounted back to the present. The capitalization formula of land value normally used in the computation of the land values is as follows:

$$V = \frac{R_1}{(1+r)} + \frac{R_2}{(1+r)^2} + \cdots + \frac{R\,n}{(1+e)^n} \qquad [1]$$

Expression [1] reduces to V = R/r as n approaches infinity, where V is the capitalized value of the property in terms of present worth, R_1 stands for the net income (or personal enjoyment) of the first year, R_2 for the net income (or personal enjoyment) of the second year, and so on, where each year's income is thought of as being received at the end of the year.

Suppose, for example, that a piece of property is expected to produce a net income (benefit) of $100 per year for an indefinite period of time, and the simple interest on alternative investment is r (say r = 0.05). What will be its price of capital value? The capital value, V, of $100 a year net earnings discounted back to the present at an annual rate R = 0.05 will simply be $100/0.05, or $2,000. If the present owner of this property has to sell, he will not rationally sell it for less than $2,000. But the amount which a potential buyer will pay for that property, will depend upon what he expects it to bring in net benefits. The present value of the flow of net benefits, compared with those obtainable from other assets, will set the upper limit.

It is not hard to see that different people might value the same piece of property differently. They might have different expectations about the size of the net benefits, or they might discount future earnings at different rates. For instance, people assign different values to a scenic view, the proximity to water, wooded land, a park, etc. While calculations of the present value of a property may differ, we can assume the market price of any actual sale must lie at or above the present value to the seller and at or below the present value to the buyer.

Now assume that a governmental agency decided to preserve for environmental and recreational purposes a large amenity area in the vicinity of that property. Further assume that the owner of the property and the investors (buyers) of the property visualize the forthcoming environmental benefits from the public program. If they do so, this newly visualized benefit would be capitalized in the market value of land near the project. As a result, land values in the neighborhood of the project will increase. If we assume that this particular environmental improvement scheme adds $100 in net benefits to the abovementioned property, the capital value would be ($100 + $100)/0.05 = $4,000 instead of $2,000 without the program. Whether the person owning that property sells it or holds it to personally enjoy the environmental improvement, he will have benefited from the public investment.

Focus of Paper

Environmental decisionmakers could apply the differential property price technique to measure the benefits of public environment projects if analysts have confidence in the ability of the approach to furnish useful information. If we are to believe that differential property prices can be used to estimate environmental benefits, we must find evidence that these benefits are in fact capitalized into property value. It is useful to review a large number of empirical studies that used this approach and examine them for evidence of such capitalization into property value.

Because it is cumbersome to concentrate on all problems at once, the main emphasis in this paper is to seek evidence of the capitalization of environmental benefits by reviewing empirical studies, rather than by examining the theoretical and methodological content.

Evidence of Residential Environmental Preferences

A considerable number of studies have attempted to develop a general model for the determination of the price of residential property. Within the framework of those models, the effect of specific dwelling attributes have been analyzed. From those studies some evidence of the capitalization of environmental attributes, such as parks, open space, lakes, etc., into residential prices has been developed.

This review consists of a brief summary of the empirical content of a number of studies done in the areas of (1) water resource development, (2) recreational projects such as state and neighborhood parks, (3) impact studies of open space preservation, and (4) air pollution.

Discussion for each group of studies will consist of a brief summary of the empirical works, followed by a discussion of several of the leading studies in each group, exploring in more detail their empirical results.

Water Resource Development Studies

There have been a number of studies on the impact of water-based developments on the value of lands near the developed area. In an early study, Knetsch (1964) attempted to develop a procedure for measuring the benefits of proposed or anticipated public investments in water resource development projects, especially benefits rising from the recreational potential. Knetsch's approach was to compare property values around an existing water-based recreation development with values in a similar area which did not possess such a development. He assumed the location advantage created by the project would be capitalized into surrounding land values and that the differences between land values in the areas with development and areas without development were caused by the investment.

Knetsch collected data on such variables as distance from reservoirs, topography, and urban proximity and related the variable to sale prices of individual parcels of land. He developed two regression equations, one for an area with a project and one for an area without. He found that land bordering a reservoir does have incremental value attributable to the development and concluded, based on his Tennessee Valley Authority data, that "If a reservoir were completed in 1963, the land is estimated to be valued at approximately $4,265,000. Without the reservoir, the value of this land is estimated to be $2,307,000; a difference in value attributable to the reservoir of $1,958,000." With a discount rate of 4%, the average annual benefit is $160,677.

David (1968) carried out a similar study in the Kissimmee River Basin in south-central Florida comparing residential lots with and without water frontage. She analyzed the effects of recreational water quality, topography, and other physical characteristics of an area on residential lot prices and found the proximity of water based recreation facilities is an important determinant of land values. As she expected, lots with water frontage commanded higher prices than similar lots without water frontage, providing a definite indication the benefits of water frontage were being capitalized into the sales value of residential lands.

David and Lord (1969), following upon David's earlier work and using the same procedures, found land bordering artificial lakes did have increased value attributable to the presence of water. Williams and Daniel (1969) found the most rapid increases in land values attributable to water developments occurred around the date project construction was announced. Significant increases in land values do not wait until the water-related benefits are actually available; rather values are capitalized based on anticipation.

Conner et al. (1973) attempted to determine the relationships of values of water frontage to other land value factors, especially structures. Prices for lots in the Kissimmee River Basin were estimated as a function of the year of sale, size of lot, and presence or absence of houses. It was found the presence of lake frontage contributed 65% of the total value of a typical vacant residential lot and 48% of the total value of lots having houses on them.

Similar but more limited studies carried out by Weiss et al. (1966), Kitchen and Hendon (1967), Mann and Mann (1968), and James (1968) tend to confirm these results.

The conclusions drawn from this research are that (1) land values rise in the vicinity of water-based recreational developments; (2) the rates of value increase are more rapid than for comparable areas without a reservoir, stream, or lake; and (3) the rates of value increase are most rapid shortly after the announcement of facility development. Thus, capitalization of future benefits occurs long before the benefits are received.

Employing data on individual dwelling units in a metropolitan area of Seattle, Wash., Brown and Pollaskowski (1977) attempted to estimate the economic contribution of proximity to water and water related open space (i.e., the land contiguous to water to which pubic has access and such areas are defined by the authors as set back) to value of single family residences.

The authors consider a housing unit as consisting of a bundle of attributes or characteristics which describe the structure itself, the land upon which it is built, and the location. The assumption was made that proximity to neighborhood amenities would describe the locational attribute of the housing bundle. As the neighborhood contained numerous bodies of water, with and without surrounding open space to which the public had access, the authors separated neighborhood amenities into two categories of variables; one was proximity to water and the other was the proximity to water-related open space with setback.

Widths of boundary areas were chosen to assure homogeneity in sample neighborhoods.

The open space variable employed was constructed by measuring the width of setback area

abutting the water and closest to the dwelling unit in question. The distance to the water front was measured as the shortest linear distance from the dwelling unit to the nearby water front.

The market prices of the dwelling unit sales transacted during the period of 1969-1974 were obtained from real estate sources. Estimates of the marginal implicit prices, or in simple terms, the marginal effect of each of the dwelling unit attributes, were obtained by regressing property price on the set of variables such as proximity to water front, setback size, lot size, living area, etc. Two different sets of regression equations, one for a lake area with setback and the other for two lake areas without setback, were used for analysis. The regression results in terms of "distance to water front with setback" and "distance to water without setback" variables were found to be significant at 0.99 level. The size of the setback variable was significant too.

The study concluded that a dwelling unit in an area close to a 200-foot-wide setback would sell for about $850 more than a comparable unit located near a 100-foot-wide setback area. The same dwelling unit, if located near a 300-foot-wide setback area, would sell for about $1,350 more than if located near a 100-foot-wide setback area. Thus, the benefits of waterfront were being capitalized in nearby property.

Park Related Studies

A number of studies have used the property value capitalization method to measure the benefits of neighborhood or other public parks. Kitchen and Hendon (1967) found that land value declined with distance from a park. A number of studies such as Weiss et al. (1966), Schutjer and Hallberg (1968), and Hammer et al. (1971) have concluded parks affect neighboring property values, implying benefits of the natural environment are being capitalized into property price.

Weicher and Zerbst (1973) applied a property value model similar to that used by Kitchen and Hendon on five parks in Columbus, Ohio. They concluded property facing a park would sell for 23% more, on the average, than identical properties elsewhere. Properties with a scenic view of the park would sell for about 10% more.

Schutjer and Hallberg (1968) attempted to evaluate the extent to which the per acre value of different types of properties located near a state park was affected by the development of the park. Taking observations on property transfers before and after the development of the park, Schutjer and Hallberg observed the influence of the park on land prices in the nearby area. In this study, the technique of measuring the benefits of a reservoir was to compare the surrounding land values before and after a project, as opposed to the Knetsch approach which employed simultaneous pricing of land with and without development of added amenities.

The authors used multiple regression analysis with 20 independent variables. Both topographical characteristics such as the slope and soil type of the land, and environmental variables such as the road distance in miles to the nearest park, were used as independent variables. A rural area of Pennsylvania was chosen as the study area. The basic data were based upon transfers of properties located near a 2,250-acre state park which is within 20 miles of two relatively large populated centers in Pennsylvania. Data were collected on 286 property transfers occurring during the period 1950-1965 in the township containing the park. These data were supplemented with information on property characteristics which were available from tax duplicates, aerial photographs, and soil surveys. Properties were classified into two groups: (1) properties containing less than two acres and (2) properties containing more than 2 acres. Each class was divided again into two types of properties, one with buildings and another without buildings. Thus, four equations were estimated. Their results showed sale price per acre was significantly influenced by the distance from the park.

Hammer et al. (1971) based their study on the assumption that all the benefits of a park, in terms of both scenery and direct accessibility, may be reflected in land values. In their statistical analysis they limited their observation to properties closer to the park than to any open space and not adjoining any retail areas or major highways. This minimized the variation in property value due to other real estate value generators. Thus, the study concentrated only on relatively homogeneous housing.

Houses were classified into 16 types to enable the separation by statistical means of the value components associated with house type from those associated with accessibility to parks.

Multiple regression was used to estimate the magnitude of the effect of proximity to the park on different types of houses. Effects were isolated by using two groups of dummy variables (i.e., one or zero variables): variables pertaining to house-type sets, and variables pertaining to the age of house at time of sale. In their model, the only independent variable present besides two groups of dummy variables was the distance to the park. Two forms of regression equations were employed, a linear form and a logarithmic form. The regression results in terms of the distance to park variable were found not signifi-

cant at the 0.05 level for the entire sample of 333 property sales. Since the magnitude of distance to the park from abutting properties was almost zero and the distance to the park from corner properties was arbitrarily measured, the authors concluded that those properties might have blurred the relationship between property price and distance variable; such properties were excluded in the regression analysis.

After 19 abutting properties and 11 corner properties were excluded from the sample, the distance variable was significant in both the linear and log forms. In order to get the locational rent, Horn and Coughlin subtracted a rough estimate of average house price from total property value, thus identifying land price. The value of the typical property, ($16,392) multiplied by 83.2% (constant for all properties in the study area), the average tax assessment for the sample property, gave an average house value of $13,638. Thus, the difference between them is the locational rent. Relative to total land value, locational rent due to the closeness of the park was found to be substantial. At 100 feet, it accounted for 35% of land value, at 1,000 feet for 11%, and at 25,000 feet for 5%.

These two empirical studies clearly indicate the existence of a park has a positive impact on surrounding land values, but the magnitude of the impact differs among types of residential properties.

Open Space Preservation Studies

There have been relatively few economic studies done to evaluate open space preservation as opposed to urbanization. One recent study done by Coughlin and Kawashima (1973) is worth discussing.

Coughlin and Kawashima attempted to measure the effect of open space on surrounding property values. They identified public open space with recreational facilities, private open space (i.e., large estates), and institutional open space (e.g., colleges, country clubs, etc.) and tested the hypothesis that open space maintained in an urban area has positive effects on adjacent property values.

Coughlin and Kawashima also attempted to find out whether the effect of open space could be seen in higher values of the buildings themselves which were located near open space. They thought that this could happen in two situations. One possible situation is that developers, consciously trying to capture the benefits of proximity to open space, may build larger and, therefore, more expensive houses on land adjacent to open space, intending to sell them to well-to-do buyers. The second possibility is that houses near open space may be of higher quality, though not larger, than houses far away. Therefore, the study was designed to explore two major questions: (1) do more expensive dwellings (including the value of land) tend to be found in locations with relatively high accessibility to open space, and (2) do higher quality (land value) dwellings tend to be found in such locations? In order to investigate these questions, the concept of accessibility of a given residential block to open space of a given type was identified. In order to give special attention to those blocks which adjoin or touch open space, a dummy variable was used. Four equations were estimated with different dependent variables. The four dependent variables were: (1) average value of owner-occupied housing unit on each block; (2) average value per room of owner-occupied housing unit on each block; (3) average contract rent of renter-occupied housing unit on each block; and (4) average contract rent per room of renter-occupied housing units on each block. Independent variables were accessibility to the types of open spaces and distance to the city in miles. The regressions were run in stepwise fashion.

From the regression result it was concluded that the accessibility to private and institutional open space was important for home owners. For renters, accessibility to public open space was important. The results of this analysis support the hypothesis that open space of various kinds has a positive effect on the capitalized and rental value of nearby properties.

The findings also support the hypothesis that both expensive and high quality dwellings are found in locations with relatively high accessibility to open space.

Furthermore, the study also attempted to estimate the magnitude of the effect of various sizes of hypothetical circular parks on the property value of the study area and the rent gradient generated by those different sizes of circular parks. The study area was divided into four rings, and the distance from the center of the park to residential properties into each ring was measured. The effects of different sizes of parks on properties in the four different rings were estimated. The results demonstrated the aggregate magnitude of the effect in the 0- to 1,000-foot ring of a 1-acre park was $171,400, the effect of a 5-acre park was $803,000, and effect of a 25-acre park was $3,485,000. Thus the study concluded that the marginal contribution of additional acres was substantial.

The magnitude of the contribution of a 1-acre park per dwelling unit was estimated at $83 in the 0- to 1,000-foot ring, $12.97 in the 1,000- to

2,500-foot ring, $3.13 in the 2,500- to 5,000-foot ring, and $0.83 in the 5,000- to 10,000-foot ring. The decreasing magnitude of the dwelling unit price difference in each of the four rings showed that the effect of a park was declining with the increases in distance from the park.

Air Pollution Studies

A number of studies have been undertaken to examine the relationship between air quality and house price. Studies of Anderson and Crocker (1971), Ridker and Henning (1967), and Strotz (1966) all conclude the effects of pollution are, to varying degrees, reflected in house prices.

The main purpose of Ridker and Henning's study (1967) was to examine whether air pollution externalities were reflected in house prices. The area of study was St. Louis, Mo., and 1960 census data were used for empirical investigation. Multiple regression was employed to estimate the relationship between house price and the following independent variables: air pollution index, housing density, population density, school quality, number of non-white people, and a set of house characteristic variables.

The results show that air quality is important and significant, and emphasize the negative effect of increasing pollution levels on property values. The authors estimated an increase of between $83 and $245 per site would result if pollution levels were cut back by 0.25 mg per 100 cm per day. The authors say the pollution variable is as important as the highway accessibility coefficient.

Summary and Conclusions

The results of this brief survey show that environmental preferences exist, and that environmental variables are significant determinants of property prices. This is so despite the fact that the measures of environmental characteristics used in various studies were quite different and were usually crude.

The empirical instances of environmental benefits being capitalized on property value found from the above reviewed literature indicate the benefits of public environmental programs can be measured through the differential property value method. Land values are affected by people's preference for proximity to a recreation area. Rent on land nearest an amenity has proven to be high, indicating individuals who locate near a site do enjoy the use and view of the area with little inconvenience. So the increment in land value near the public project area could be taken as the benefit of the site.

This method does not provide complete estimates of value when there are significant benefits outside the area nearest the public environment project. The property value approach is applicable only when there is a sufficient quantity of private properties being exchanged near the public project. The increase in property value due to a public project is an underestimation of the total gain from public projects, since environmental and recreational benefits are enjoyed by parties other than residential property owners. For example, when water or other recreation areas are developed by public investment, many other businesses such as building trades, retail businesses, grocery stores, sporting goods suppliers, and the like may also benefit. All these secondary effects of public investment are not estimated through the property value method. Therefore, the method provides a lower bound (minimum) estimate of the benefits of public environment projects (Lind 1973). A further problem which Lind considers in more detail is a possible discrepancy between land value and net benefits. The market for land may be such that not all changes in business profit and consumer's benefits can be captured in land values. However, it is also possible that if a number of similar activities are competing for each parcel of land, the land value change will capture the benefits of competing activities also. Separating which projects or activities contributed to the change in land values would be difficult.

The house price studies reviewed in this study provide some evidence of the capitalization of the benefits of environmental services into property values, but the evidence is not enough to suggest which specific kind of environmental goods consumers perceive as environmental amenities. The missing feature in past research is the absence of a theory which is adequate to explain consumer's residential choice behavior in terms of environmental variables. Future studies should fill this gap. Incorporation of an appropriate econometric model into a theoretical framework is required to pinpoint the effect of specific environmental attributes on property prices.

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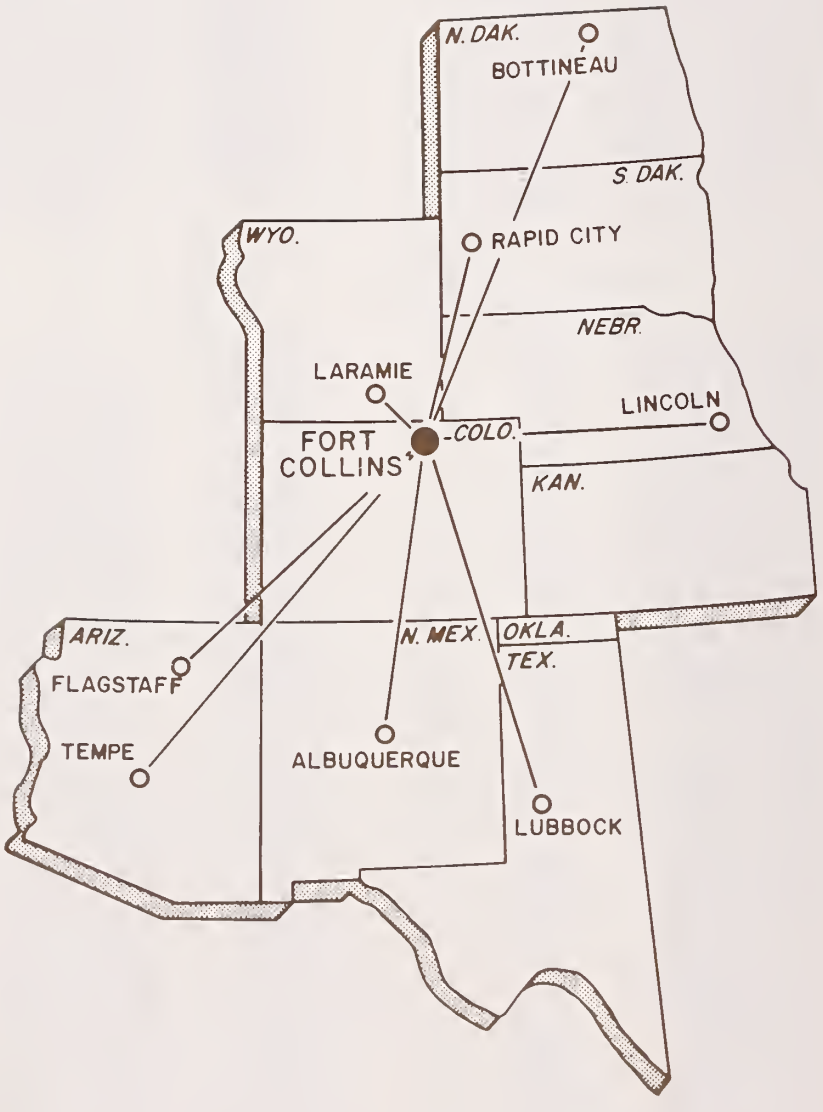
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